Inferred fluid flow behaviour in a red-bed fractured aquifer: St Bees Sandstone Formation, UK

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Understanding fluid-flow behaviour in arenaceous red-bed successions is globally important because such accumulations represent major aquifers for water supplies, geothermal energy and hydrocarbon reservoirs. The St Bees Sandstone Formation comprises Triassic fluvial red-beds and represents a case study to address this issue. This geological formation is part of the Sherwood Sandstone Group, which is the UK's second most important aquifer. The formation is dominated by channelized fluvial architectural elements in which sandstones represent the most permeable lithology based on laboratory analyses (porosity 18 - 22%; K_h 800 - 4000 mD; K_v 150 - 700 mD). Mud-prone fluvial overbank architectural elements occur both at the base of channel belts and as interbedded bodies within channelized elements. Overbank elements are characterized by lower porosity and permeability values (porosity 14% - 18%; K_v 3 - 10 mD; K_h 50 - 400 mD) with respect to channelized elements, and therefore represent a key heterogeneity. Multi-level piezometer data indicate that the aquifer is horizontally layered whereas overbank elements enhance the aquifer's layer-cake behaviour when they are interbedded in channelized elements. Another sedimentary heterogeneity is represented by white, in-channel silty sandstone drapes (porosity from 8% - 10%; permeability values of a few milliDarcies). Although matrix conduits facilitate fluid flow, tectonic features, which have been characterised through scanline surveys, also potentially represent significant fluid pathways. Vertical joints form strata-bound systems which terminate at bedding surfaces; bedding-parallel fractures establish communication between sub-vertical joints in adjacent units. Additionally, normal faults have extended damage zones with high fracturing density and high connectivity. The work conducted, that will be completed analysing pumping tests, has revealed how the St Bees Sandstone Formation potentially represents a heterogeneous dual-permeability aquifer.